NATIONAL GEOGRAPHIC

Our MATHEMATICAL WORLD

What do they have in common?

The answer is maths.

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The Golden Ratio

The mathematical language of beauty

Our mathematical world

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The Golden Ratio

Can beauty be expressed in mathematical terms? Since ancient times, the golden ratio has been linked to harmony in art and nature, to the point of meriting the title of 'divine'. We not only find it in the smile of the Mona Lisa, but also on the petals of roses, in the form of some animals and in the spiral arms of galaxies.

Our mathematical world

01
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Mathematicians, Spies and Hackers

Coding and cryptography

Our mathematical world

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Mathematicians, Spies and Hackers

The integrity and confidentiality of communications depends on complex codes designed by mathematicians. This book offers a stimulating arithmetic journey through security and secrecy, reveals the encryptors who have decided the fate of nations and uncovers the language through which computers communicate.

Our mathematical world

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Prime Numbers

A long road to infinity

Our mathematical world

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Prime Numbers

Most numbers behave according to simple and clear rules. By contrast, prime numbers are a real nuisance: they appear where they want, without notice, in a seemingly chaotic way, and without following any pattern. And the worst part is that they cannot be ignored: they are the essence of arithmetic and, to some extent, of all mathematics.

Our mathematical world

03
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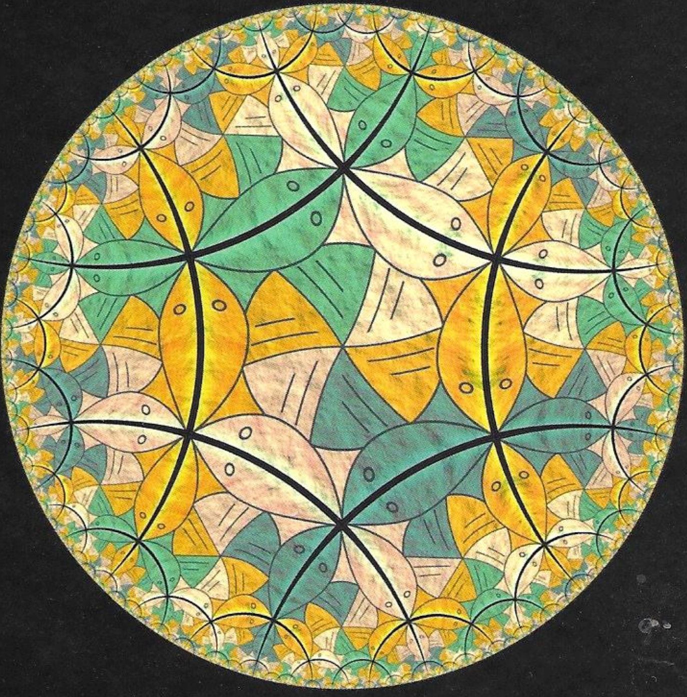
When Straight Lines become Curves

Non-Euclidean geometry



Our mathematical world

NATIONAL GEOGRAPHIC

When Straight Lines become Curves

Since the time of Euclid more than two thousand years ago, there seemed to be only one geometry. However, new mathematical developments have shattered this certainty proposing alternative geometries where universes are bent sharply. It may seem crazy, but all these worlds exist, and we inhabit them simultaneously.

Our mathematical world

04
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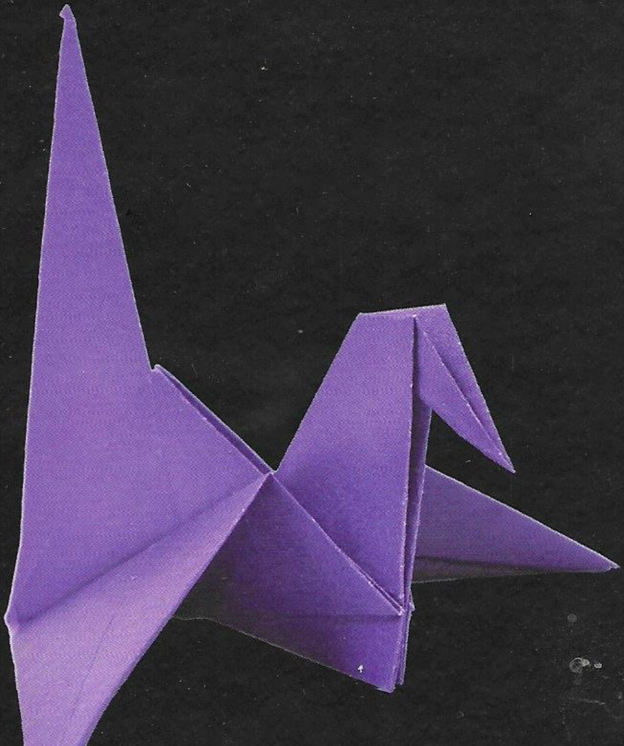
The Sect of Numbers

Pythagoras' theorem



Our mathematical world

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The Sect of Numbers

The relationship between the hypotenuse and the other two sides of a triangle is one of the most important scientific findings, with surprising consequences in geometry and number theory. The theorem that reflects this relationship takes its name from Pythagoras, one of the most intriguing and surprising people in the history of science; an inspirational leader of a mystic circle that combined religion and mathematics.

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Secrets of π

Why is it impossible to square the circle?

Our mathematical world

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Secrets of π

You may remember it as 22 4 7, or 3.14159...., but what is it? Better known as π, this number describes the relationship between the diameter of a circle and its circumference.
It is a number that has fascinated mathematicians since the time of the Ancient Greeks, and has aroused more controversy and debate than any other number.

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Fermat's Enigma

Three centuries of mathematical challenge

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Fermat's Enigma

No other conjecture in the history of mathematics is as suggestive as enunciated by the French mathematician Pierre de Fermat in 1637. The simplicity of its design contrasts with the deep mathematics addressing the theorem, which came to be seen as unprovable.

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Prisoners with Dilemmas and Dominant Strategies

Game theory

Our mathematical world

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Prisoners with Dilemmas and Dominant Strategies

Game playing – an ever-popular pastime – has always prompted intriguing mathematical explanations and formulations. This process reached its climax in the second half of the last century when, in the heat of the Cold War, against a backdrop of ideological and military confrontation between global superpowers, modern game theory was developed to analyse winning strategies that can be used to tackle all types of conflicts.

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A New Way of Seeing the World

Fractal geometry

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A New Way of Seeing the World

Many natural phenomena exhibit irregular and even chaotic shapes that cannot be analysed using traditional geometry: the sponginess of the clouds, the branches of trees, the zig-zags of lightning bolts. We can seek insights into these apparently random elements of nature in the revolutionary mathematical concept of fractals – a new way of looking at the world based on the maxim 'the whole contains the part and the part the whole'.

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Underground Maps and Neural Networks

The theory of graphs

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Underground Maps and Neural Networks

A graph is an extraordinarily simple construct: a set of points joined by lines. Graphs include everything from metro maps to the delivery route taken by a postal worker. In fact, graphs can describe the multitude of networks that form the basis of our world. Carefully observing these simple structures opens our eyes to a universe of links and connections in which mathematics reigns supreme.

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The Fourth Dimension

Is our Universe the shadow of another?

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The Fourth Dimension

The idea that there are extra dimensions beyond our senses has fascinated scientists over the centuries. Although it may seem impossible to imagine a world with more than three dimensions, mathematics shows us how we can conceive multidimensional space, and opens our eyes to a world of ghostly apparitions and impossible objects.

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Harmony is Numerical

Music and mathematics

Our mathematical world

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Harmony is Numerical

A great mathematician once said that music was "the pleasure that the human mind experiences from counting without being aware of it." There are many fascinating connections between music and mathematics, from the relationship between harmony and numbers – an idea that has amazed mathematicians since the time of Pythagoras – to the ingenious techniques of repetition and translation used to stunning effect by legendary composers such as Bach and Mozart to compose their greatest masterpieces.

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Absolute Certainty and Other Fictions

The secrets of statistics

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Absolute Certainty and Other Fictions

Statistics has been described as the practice of 'torturing numbers to make them confess'. This observation possibly has its roots in the fact that any examination of statistics starts from the conviction that 'certain' means little more than 'highly probable'. However, the study of statistics is undoubtedly the most important branch of applied mathematics, and can often represent our best guide to taking crucial decisions in the face of uncertainty.

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The Truth is at the Limit

Infinitesimal calculus

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The Truth is at the Limit

The importance of calculus and of concepts such as ‘derivatives’ and ‘integrals’ is hard to underestimate. It has been said that without them the scientific revolution would have been impossible. Although their origins date back to the Ancient World, the crucial breakthrough came with the simultaneous work of two giants of Western thought: Leibniz and Newton. Their battle to lay claim to the discovery of these key mathematical concepts shook the world of 17th-century science in Europe.

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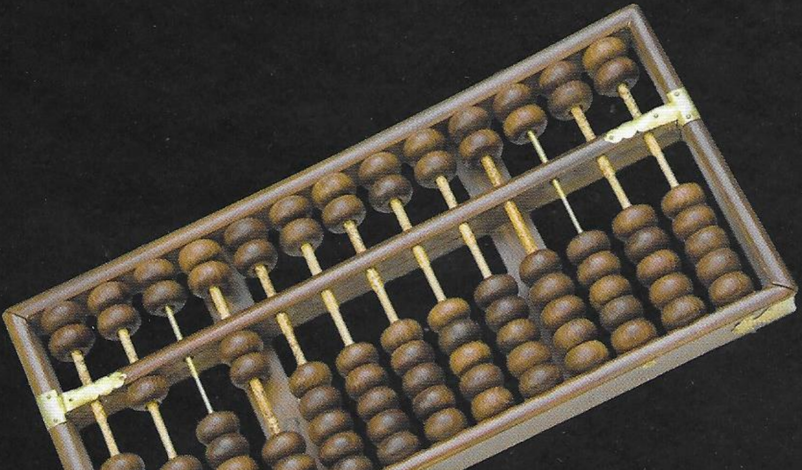
From the Abacus to the Digital Revolution

Algorithms and computing



Our mathematical world

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From the Abacus to the Digital Revolution

Throughout their evolution, calculating tools have always been the result of the available technology and the numbering system in popular use at any given time. From prehistoric accounts of the Roman abacus and Arabic algorithms, to the first automatic calculators, the history of calculation is also largely a history of numbering systems. The most recent milestone in this ongoing evolutionary process has been the development of modern-day computers and computing systems, which are continually being refined towards the same goal: to provide increasingly powerful tools to carry out ever more complex calculations.

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Playing with the Senses

Art through mathematical eyes

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Playing with the Senses

The relationship between art and mathematics is deeper and more complex than it seems at first sight. The development of mathematics and art, as creative human activities, have followed parallel historical paths. The concepts of time, space and measurement, avidly studied by mathematicians through the ages, also form the basis of artistic creation. Looking at art through the prism of mathematics provides us with a unique and amazing aid in appreciating the greatest works of art the world has to offer.

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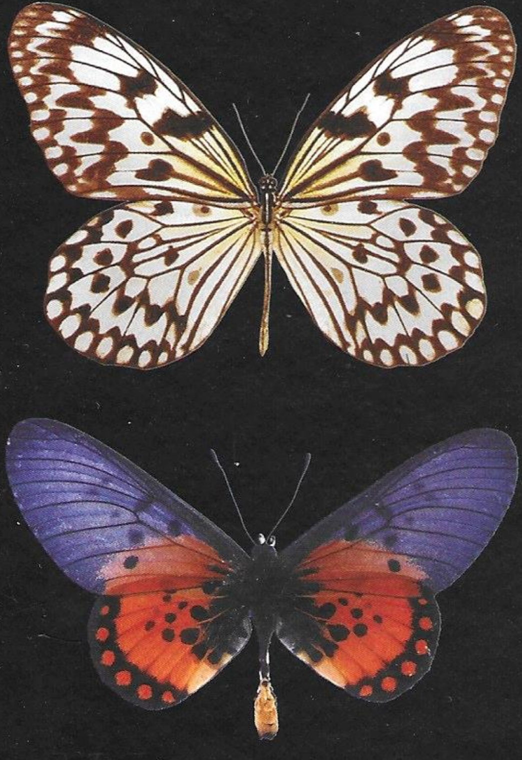
On the Other Side of the Mirror

Symmetry in mathematics



Our mathematical world

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On the Other Side of the Mirror

The study of symmetry is an attempt to understand beauty better – and enjoy it more. Ideals of beauty are, to a great extent, based on notions of proportionality and equilibrium. Furthermore, symmetry constitutes a fundamental concept in the study of the world around us. There are many symmetries, ranging from the fictional Alice and her journey through the looking glass, to the fascinating world of group theory. The intriguing field of symmetry offers a deeper insight into one of the fundamental threads in the tapestry of contemporary mathematics.

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An Endless Discovery

Mathematical infinity

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An Endless Discovery

If the search for knowledge is compared to a treasure hunt, a complete understanding of the theory of infinity would without doubt be the greatest prize of all. Carving a path between dogma and paradox, the concept of infinity has always been a nebulous yet tangible presence in the landscapes of ancient philosophy, medieval religion and modern science. This book follows the elusive trail of infinity through the minds of philosophers, theologians, physicists and, above all, mathematicians.

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Mortgages and Equations

Mathematics of the economy

Our mathematical world

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Mortgages and Equations

A large part of our day-to-day mathematical tasks are related in one way or another to economic science: we compare prices, we calculate the change when we buy something, we read about inflation or unemployment in the news... In fact, it is highly likely that taking out a bank loan or a mortgage will be the most mathematically challenging decision of our lives. This volume provides an accessible yet rigorous explanation of the mathematics underlying the economy and the finances of people and nations around the world.

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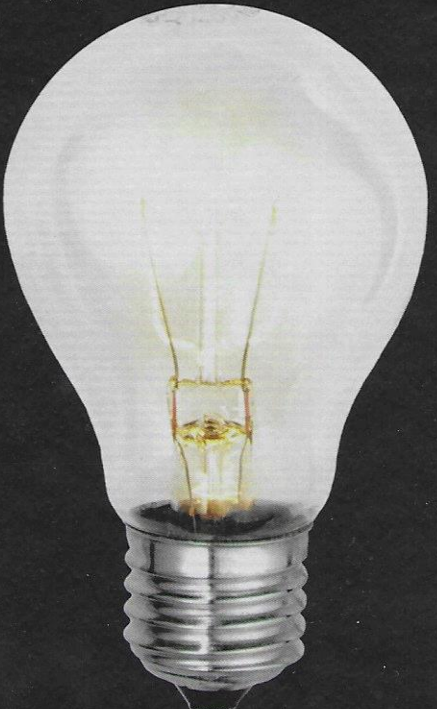
Creativity in Mathematics

How a marvellous mind works



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Creativity in Mathematics

Anyone and everyone can create mathematics! Using historical and contemporary examples from societies around the globe, this book demonstrates that mathematics is a democratic activity. The reader will discover the endlessly beautiful simplicity and complexity of mathematics, and learn that the secret to a lively mind is to 'live mathematically' a little every day.

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Notable Numbers

0, 666 and other numerical beasts

Our mathematical world

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Notable Numbers

Why are some numbers significant? There are numbers that are important to mathematicians, such as 0. Other numbers hold special resonance in certain religions, such as '3' or '666'. And there are also those with significance for gamblers, such as '13'. Regardless of whether we are mathematicians, believers or simply enjoy playing games of chance – or even all three or none – the importance and influence of numbers permeate our lives.

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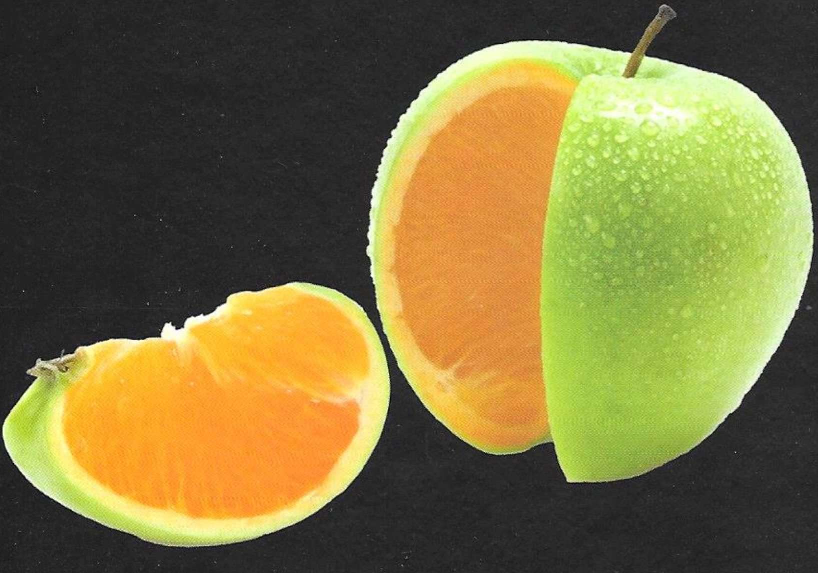
The Dream of Reason

Mathematical logic and its paradoxes



Our mathematical world

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The Dream of Reason

During the early decades of the 20th century, a pair of eminent logicians, Bertrand Russell and Kurt Gödel, shook the established pillars of the imposing mathematical edifice that had been under careful construction since the times of Euclid. Pioneering the use of logic to understand the foundations of mathematics, some see these figures as a major influence in introducing logic into the absorbing realm of modern computing.

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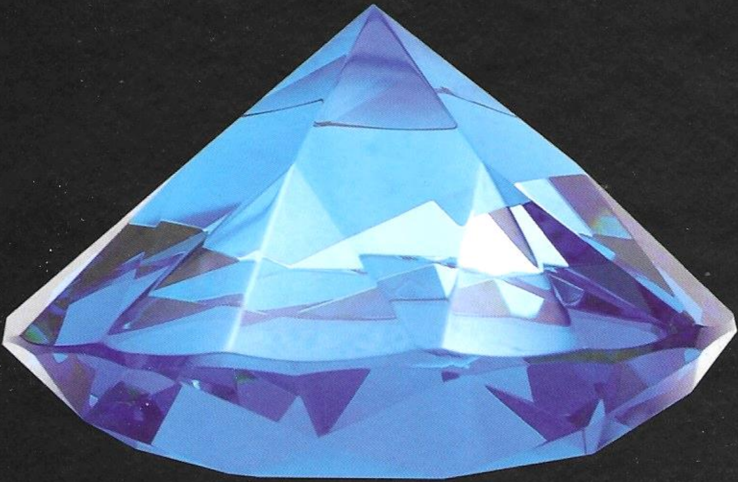
The Thousand Faces of Geometric Beauty

The polyhedra



Our mathematical world

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The Thousand Faces of Geometric Beauty

In the world of geometric bodies, certain shapes stand out for their special glamour: polyhedra – geometric solids in three dimensions with flat faces and straight edges. They live among us daily and provide artistic shapes of great beauty, as well as having extremely useful functions. They have always been of interest to architects, painters, sculptors and jewellers… Come and admire these exceptional shapes!

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The Conquest of Chance

Probability theory

Our mathematical world

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The Conquest of Chance

The taming of chance by reducing it to numbers is one of the most formidable achievements of the human intellect. Where there was once only a choice between the extremes of absolute certainty and radical doubt, a landscape of infinite gradations between the two has opened up before us. Today, the field of probability theory constitutes one of the most fascinating branches of modern mathematics.

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Fleeting Ideas, Eternal Theorems

Great problems in mathematics

Our mathematical world

NATIONAL GEOGRAPHIC

Fleeting Ideas, Eternal Theorems

What constitutes a relevant problem in mathematics? This volume attempts to provide an answer to this question, exploring dozens of intriguing conundrums. Some of them appear to be complicated but turn out to be simple, while others, which at first glance seem to be very easy, are much more challenging. The book provides an eye-opening history of mathematical problem-solving through examples that have obsessed mathematicians throughout the ages.

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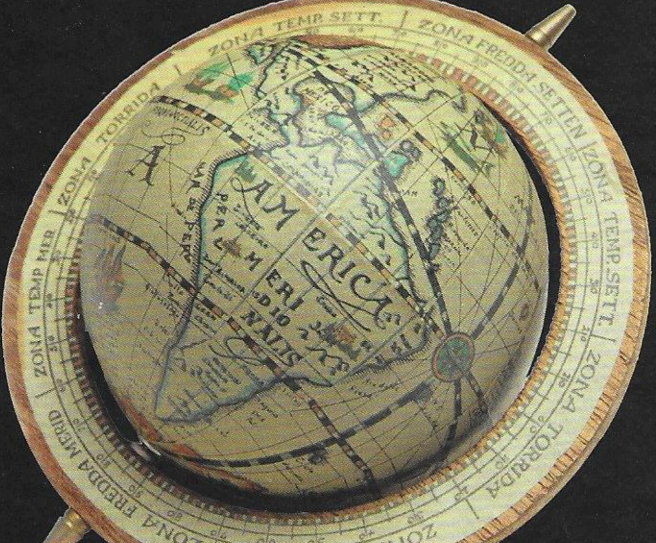
The Dream of the Perfect Map

Cartography and mathematics



Our mathematical world

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The Dream of the Perfect Map

Many of us recall world maps, displayed on the classroom wall, in which a gigantic Greenland existed alongside a tiny South America. Why were the dimensions of the continents so obviously wrong? The reason, we now know, is that when attempting to project the surface of the globe onto a two-dimensional plane, we have no choice other than to distort reality. The perfect flat map belongs in the same category as unicorns or proofs of squaring the circle: it does not exist! However, the history of how this conclusion was reached and the attempts to solve this problem constitute an absorbing episode in the history of mathematics.

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The Poetry of Numbers

The role of beauty in mathematics

Our mathematical world

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The Poetry of Numbers

The dictionary states that mathematics is a deductive science that studies the properties of abstract entities, such as numbers and geometric shapes, and their relationships. However, this definition misses out on a fundamental fact: more often than not, mathematics is guided by poetic emotion and a sense of beauty. The purpose of this book is to illustrate, using examples from the history of the discipline, the extremely important aesthetic and emotional dimensions in the science of mathematics.

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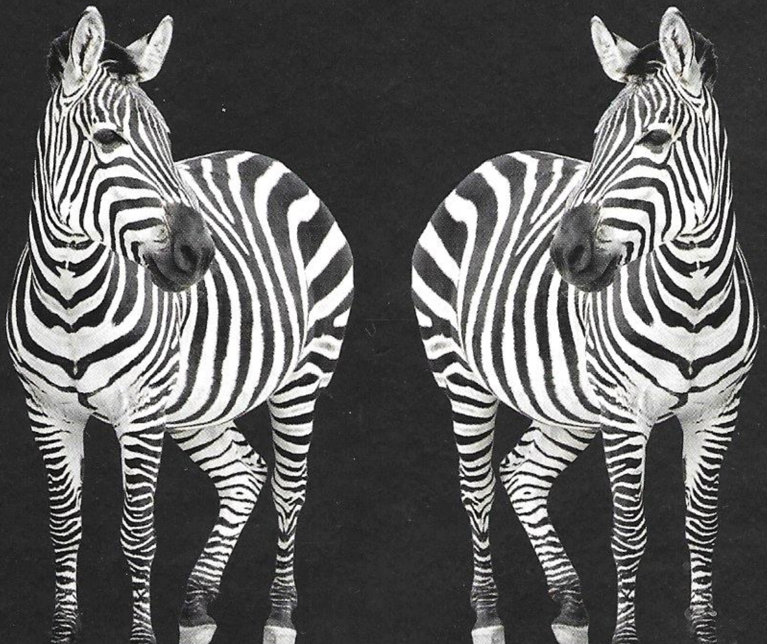
The Mathematics of Life

Numbers in biology and ecology



Our mathematical world

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The Mathematics of Life

The life of the world around us may often seem to be a mesmerising chaos of shifting shapes: compelling and engrossing, but tumultuous. However, when we put on our mathematical glasses, in many instances, chaos turns magically to order. In this book, the reader can discover the key concepts of mathematical biology, illustrated with numerous examples and surprising applications from the real world.

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Curious Curves

Ellipses, hyperbolae and other geometric wonders

Our mathematical world

NATIONAL GEOGRAPHIC

Curious Curves

A famous writer once distinguished between the 'lines of the intellect' and the 'curves of the emotions'. Accepting this metaphor, readers should be warned that this book, despite dealing with mathematics, abounds with emotion on every page! Its elegant and sinuous heroines are known by suggestive names such as ellipse, hyperbola, spiral and conchoid, and their fine definition and seductive properties have turned the heads of mathematicians since the dawn of thought itself!

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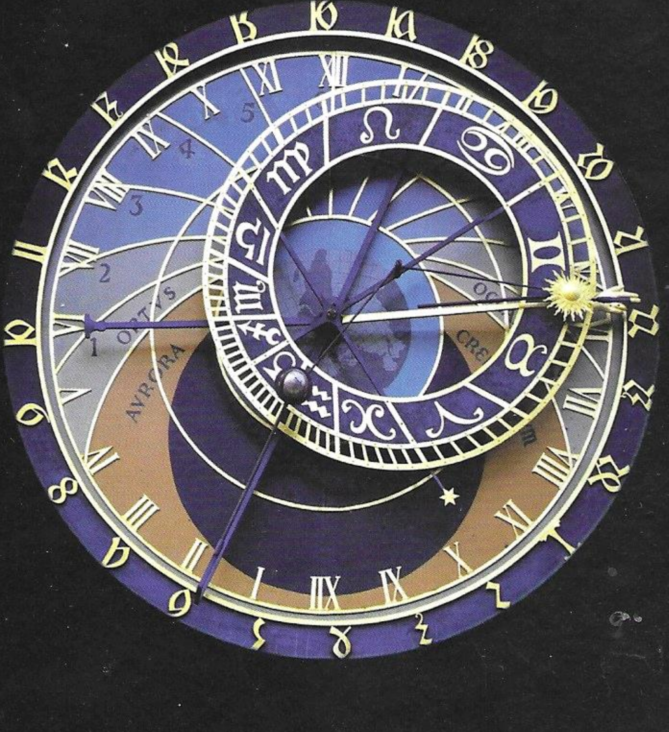
Cosmic Calculations

Astronomy and mathematics



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Cosmic Calculations

Mathematics and astronomy began their journey together thousands of years ago. The Babylonian, Greek and Hindu civilisations were among the most passionate in their quest to establish the rules – halfway between magic and science – for the cosmic dance of the stars and planets. Because it was such a useful guide for travellers, astronomy was one of the first and most important applications that humankind found for scientific thinking. From those early days, mathematics has been the vehicle that has helped the intellect to travel even further – to the edges of the Universe and beyond.

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The Secret Life of Numbers

Mathematical curiosities

Our mathematical world

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The Secret Life of Numbers

At the heart of a great deal of serious mathematics lie many mind-boggling anecdotes and crazy curiosities. Mathematicians are famously perceived as eccentric, and this book does nothing to dispel this popular image! What it does do, however, is to uncover the hidden side of mathematics, which is full of absorbing scientific insights, and is fascinating to unravel.

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The Butterfly and the Tornado

Chaos theory and climate change

Our mathematical world

NATIONAL GEOGRAPHIC

The Butterfly and the Tornado

It is possible that readers will already be familiar with the hypothetical situation whereby a butterfly flapping its wings in Brazil can cause a tornado in Texas. However, the answer to the following question is perhaps more interesting: can a butterfly flapping its wings in Brazil PREVENT a tornado over Singapore? This book tackles this and other knotty problems related to the climate and its changes, as well as looking at other applications of chaos theory concerning populations and epidemics, brain signals and heartbeats.

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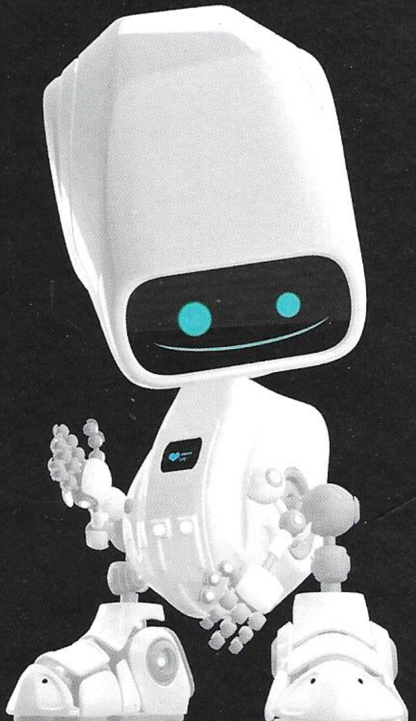
Minds, Machines and Mathematics

Artificial intelligence and its challenges



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Minds, Machines and Mathematics

We are used to seeing weird and wonderful visions of the future on TV and in films, where machines have become autonomous and are able to make their own decisions, often with terrifying consequences for humanity. But how can we separate reality from myth? Exactly how far advanced is artificial intelligence today? This book promises a thrilling journey through the future of intelligence and the role that will undoubtedly be played by mathematics in the scientific adventure ahead.

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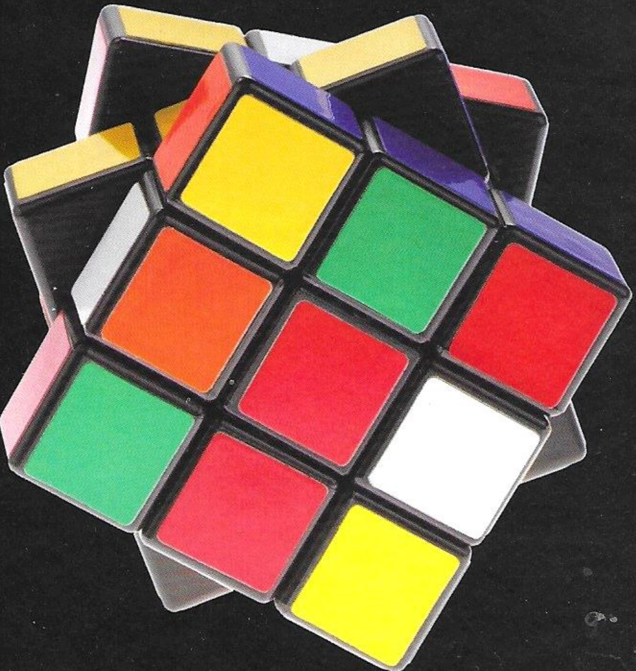
The Art of Counting

Enumeration and combinatorics



Our mathematical world

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The Art of Counting

Many of the most important questions in modern mathematics require mastery of an extremely special art: counting. The branch of mathematics responsible for turning enumeration into an art form is called 'combinatorics', and thanks to legendary figures such as Paul Erdös, this field has formed the basis of some of the most amazing mathematical developments of the new millennium.

Our mathematical world

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NATIONAL GEOGRAPHIC

Until Algebra do us Part

Group theory and its applications

Our mathematical world

NATIONAL GEOGRAPHIC

Until Algebra do us Part

The French thinkers André Weil and Claude Lévi-Strauss – the former a mathematician, the latter an anthropologist – are among the greatest intellectuals of recent times. Group theory, one of the fields of expertise of Weil, is explained by means of a fictional dialogue between the two men, throwing light on the study of the structures built by societies, and their rituals, as researched by Lévi-Strauss. The book presents an illuminating study of the confluence of mathematics and human behaviour, as well as vivid portraits of two geniuses.

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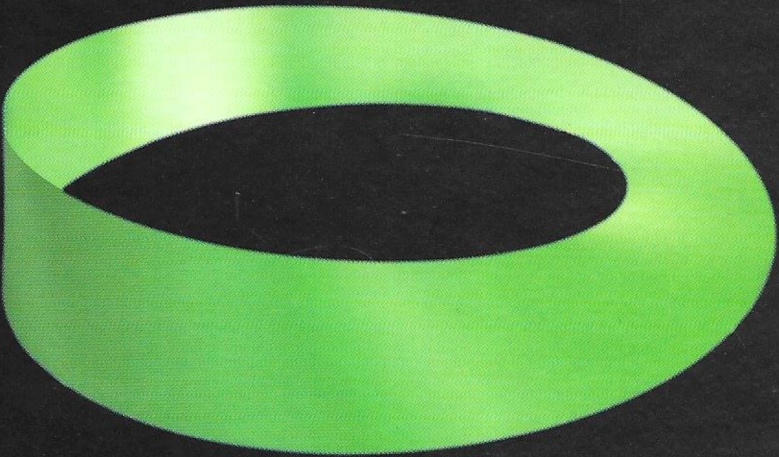
Distorting and Transforming Shapes

Mathematical topology



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Distorting and Transforming Shapes

Topology concerns the study of shapes, and regards one shape as being equal to another if it can be recreated from the first without 'breaking' it. This is why topologists have been lightheartedly described as mathematicians who are unable to tell a doughnut from a coffee mug! More seriously, topology is an important branch of mathematics, despite the fact that to the uninitiated it does not look like mathematics at all: without formulae, equations and functions… without even numbers and letters! Few disciplines are more abstract and, at the same time, more stimulating. Welcome to the exciting world of topology!

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Women in Mathematics

From Hypatia to Emmy Noether

Our mathematical world

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Women in Mathematics

Once upon a time, one of the most deeply rooted myths in mathematics was that its abstract nature meant that women would encounter special difficulties when it came to understanding and practising the discipline. One only has to learn of the contributions made by women such as Hypatia, Maria Gaetana Agnesi, Sofia Kovalevskaya and Emmy Noether to know that this was never true. In fact, these and the other key female mathematicians included in this volume are worthy of admiration not only for their intellectual achievements, but also for having overcome the male-oriented prejudice of their times to make an indelible mark on the history of mathematics.

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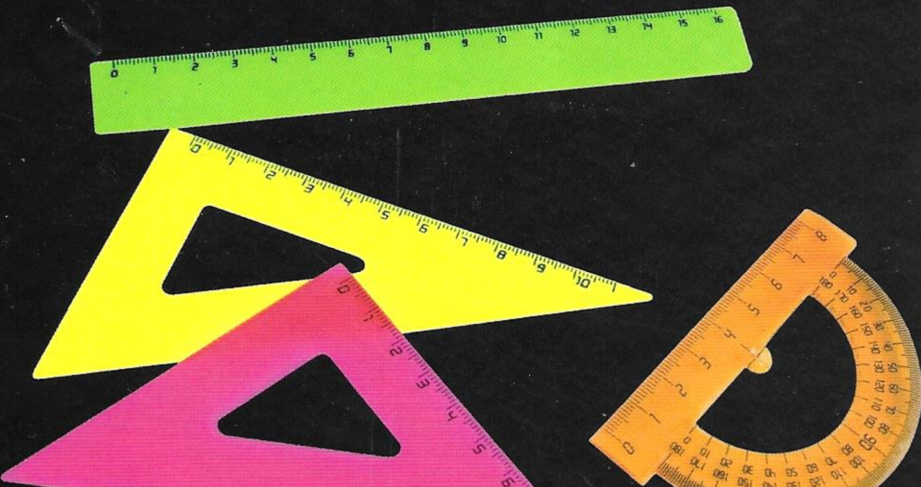
Getting the Measure of the World

Calendars, lengths and mathematics



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Getting the Measure of the World

How much time has passed? How high is the Moon? How heavy is an elephant? The vital mathematical field of measurement allows us to respond precisely to a multitude of variables that cannot be classified in any other way. Furthermore, the standardisation of measurements has allowed us to speak the same language throughout the world. Without measurement and mathematics, we would live in a very different, almost unimaginable world!

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Mathematical Network

International groups and congresses

Our mathematical world

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Mathematical Network

Since 1897, every four years the world's mathematical elite gather at international congresses where they present and discuss the most significant advances in the discipline. The history of these congresses reveals to us the extent to which mathematics, often seen as the result of individual contributions from a few geniuses, is, in fact, largely the result of interactions among like-minded people, who pool their knowledge for the benefit of all humanity.

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NATIONAL GEOGRAPHIC

Planet Mathematics

A numerical journey around the world

Our mathematical world

NATIONAL GEOGRAPHIC

Planet Mathematics

All peoples and cultures have their own distinctive view of the world, influenced by beliefs, rites, customs, artistic endeavours, language, food, technology, … and mathematics. This book takes us on a fascinating numerical journey through history and across cultures, stopping off throughout the length and breadth of the globe – with the mathematical imagination as our guide!

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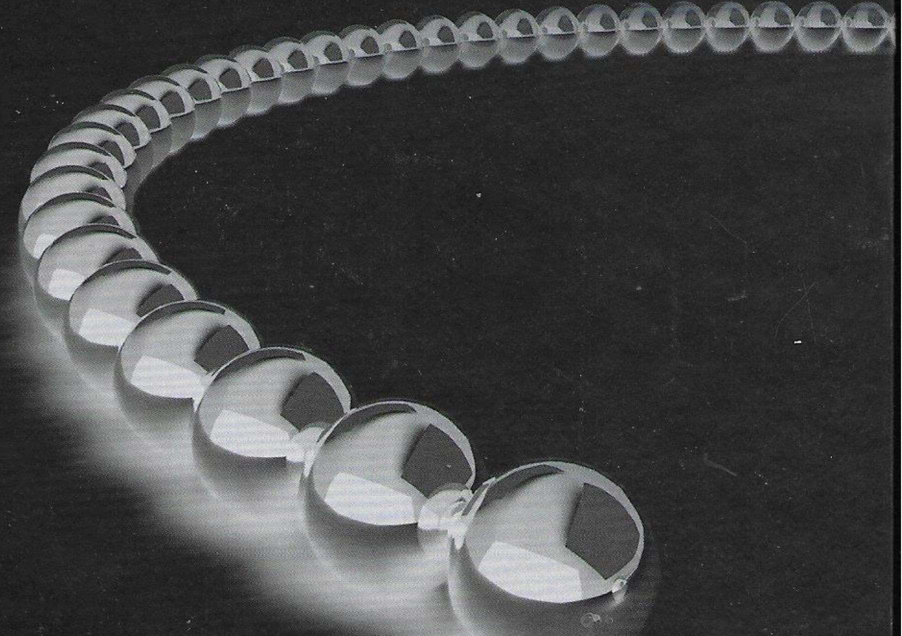
The Sphere that Wanted to be Infinite

The paradoxes of measurement



Our mathematical world

NATIONAL GEOGRAPHIC

The Sphere that Wanted to be Infinite

Can you cut a sphere into several pieces and then reassemble the pieces to make two spheres equal in size to the original? Common sense tells us no. However, in 1924, Stefan Banach and Alfred Tarski used mathematics to prove that you can duplicate a sphere by simply cutting it into eight pieces and then reordering them. We examine these and other surprising questions before asking ourselves what does it really mean to measure volume, length or area. Or how is it possible that objects can exist with more than two dimensions but less than three.

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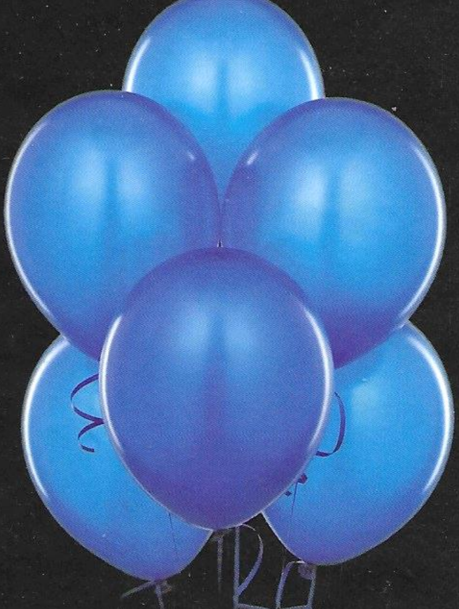
A Mathematical Journey from the Particle to Everything

The mathematics of gases



Our mathematical world

NATIONAL GEOGRAPHIC

A Mathematical Journey from the Particle to Everything

Physics and mathematics have been developing in parallel for centuries, to such an extent that any advance in one inevitably has repercussions on the other. One spectacular example of this symbiosis can be seen in the study of gases, where the analysis of their billions of component particles could only be performed after the creation of sufficiently powerful mathematical techniques. This book is a journey through these techniques, whose applications ended up going far beyond the realm of physics.

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NATIONAL GEOGRAPHIC

Unsolvable Problems – do they Exist?

Mathematics, complexity and computing

Our mathematical world

NATIONAL GEOGRAPHIC

Unsolvable Problems – do they Exist?

How do we measure a problem's complexity? Will we one day be able to find simple solutions to difficult problems? The theory of computational complexity tackles these questions and others, many of which still have no answer. There are obvious practical applications, such as cryptography, which depend on the answer to these questions. But the theory also sheds light on profound mathematical and philosophical problems related to intelligence and knowledge.

Our mathematical world

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NATIONAL GEOGRAPHIC

Endless Mosaics

Tessellations and drawings on the plane

Our mathematical world

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Endless Mosaics

We walk on them at home and in the street, where they decorate façades, furniture and a variety of other objects. We dress ourselves in garments that are tailored and patterned with them, and we even taste them in the form of pizza or cake. We spend long periods of time absorbed in their assembly, to produce results that go way beyond the sum of their parts. And thanks to their designs and colours, it is possible to identify them with a town or a particular culture. In the mosaic of cultures that makes up the world, mathematics represents the culture of the mosaic.

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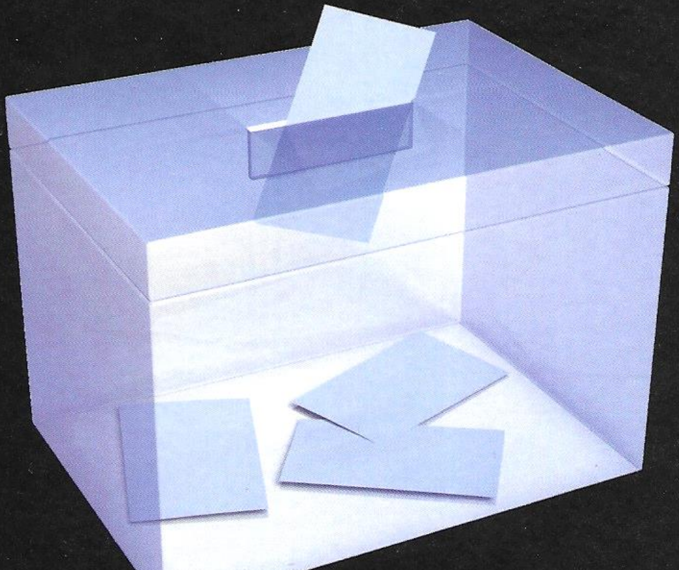
When Mathematics goes to the Polls

Decision processes



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When Mathematics goes to the Polls

The area of decision-making is one that looks into the manner in which we manage to draw conclusions regarding the occurrences of daily life. This is a discipline that finds itself somewhere amongst economics, statistics, psychology and, more recently, information technology, thanks to developments in artificial intelligence. This book touches on some of the most-relevant topics in the making of decisions, centring itself on the perspective of mathematical models that allow one to make decisions in the most-optimal manner. It thoroughly analyses multiple-criteria decision-making, adversarial decision-making (game theory and artificial intelligence in games) and methods of social choice, including electoral systems.

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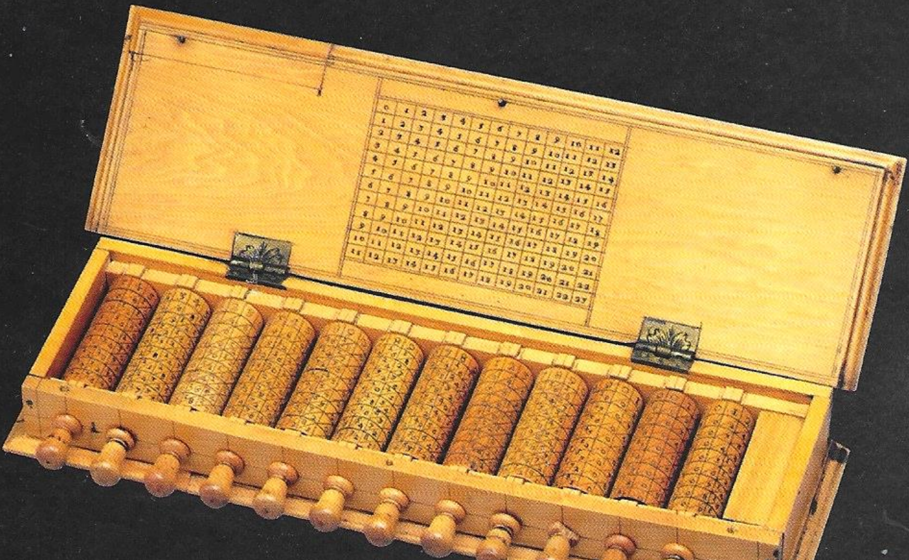
e for Extraordinary

The history and applications of the constant *e*



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e for Extraordinary

Irrational and transcendental *e* is one of those numbers that occupies a prominent place in mathematics, like π or the so-called golden ratio, symbolised by the Greek letter φ. All have historical anecdotes attached to them and have given mathematicians important practical applications.
The number *e*, the extraordinary protagonist of this book, was a key element in the discovery of logarithms and is essential to formulae widely used in physics, economics and biology. But *e* also has a unique attribute: it is part of the Euler formula, which is considered the most beautiful in the world. What more could you ask for in a number?

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Easy or Difficult?

Learning and teaching mathematics

Our mathematical world

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Easy or Difficult?

Mathematics is renowned for being difficult because of its tendency towards abstraction, but it is an essential tool for understanding the world in which we live. The way in which mathematics is studied reflects the prevailing conception of the discipline and the teaching methods in use. Nowadays, knowing mathematics means doing mathematics, putting it into practice: counting, calculating, locating, designing, explaining and playing — the six basic operations in any culture, inextricably linked to mathematical reality. If a teacher knows how to give pupils the appropriate tools and stir their interest by connecting with their reality, then the rest is child's play.

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Mathematical Bits

Data theory and communications

Our mathematical world

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Mathematical Bits

The challenges faced by telecommunications in a highly technical society are increasing on a daily basis: data transfer volumes are growing exponentially, creating a need for new formulas to transmit signals that allow for greater compression of the same, protected by encryption and security measures whose complexity must continuously develop. Behind all these challenges lies a fundamental tool, mathematics, and a set of basic principles, information theory.

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NATIONAL GEOGRAPHIC

Mathematics on the Front Page

Statistics and the media

Our mathematical world

NATIONAL GEOGRAPHIC

Mathematics on the Front Page

Numbers are often considered more dispassionate and reliable than words, but they also have their dark side, as they can sometimes be manipulated to construct alternative views of reality. This rigorous but highly accessible book, leavened with humour and numerous examples, guides the reader through the maze of information presented in the media via statistics, graphs and percentages, providing the keys for distinguishing serious analysis from self-serving puffery.

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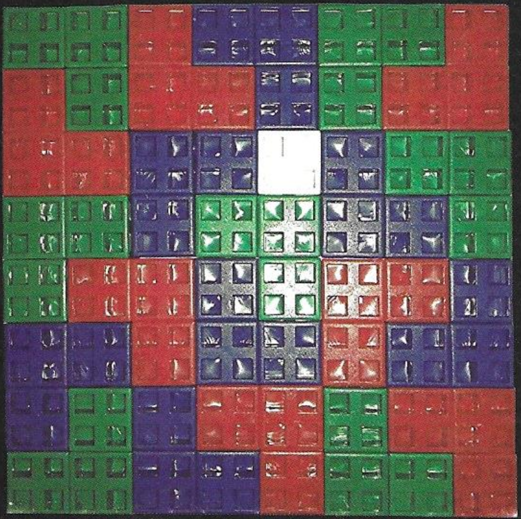
From Chess to Graphs

The mathematical seriousness of games



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From Chess to Graphs

Games are a basic part of daily life for people of all ages and social status and have played a role in mankind's story since our beginnings. But where does maths come into it? Given the parallel between mathematical thinking and solving puzzles, it's no wonder that great mathematical minds have thrown themselves into finding winning strategies for competitive games, solving complex brain teasers, and analysing all sorts of pastimes in depth, leading to the creation of many fascinating and ingenious games.

Our mathematical world

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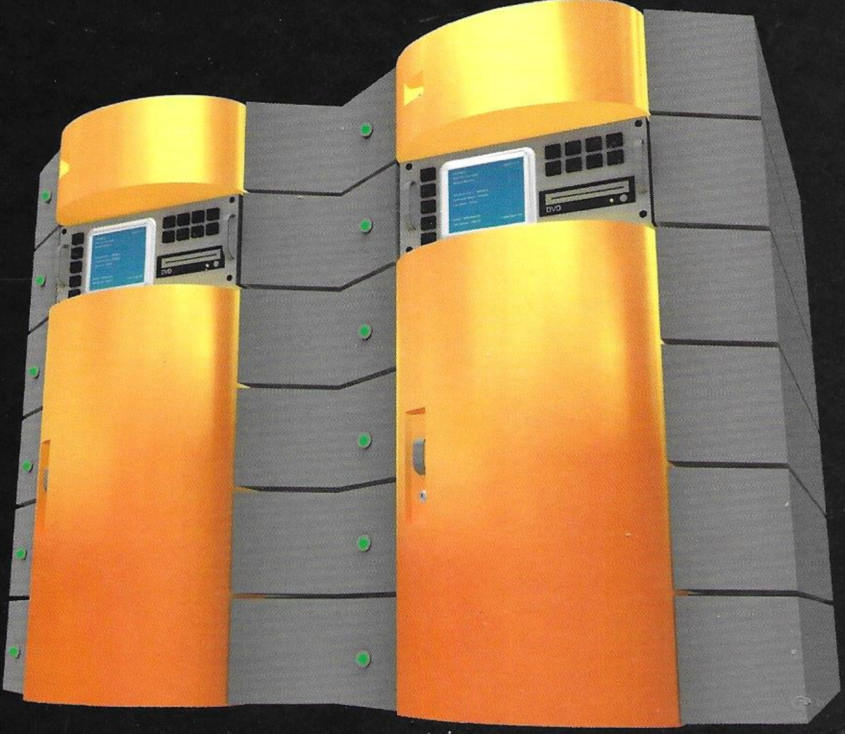
NATIONAL GEOGRAPHIC

The Power of Data

From big data to deep learning



Our mathematical world

NATIONAL GEOGRAPHIC

The Power of Data

Big data plays an ever-increasing role in our lives. It is nowadays seen as the new crude oil, a raw material with lots of potential but which needs refining in order to have any value. This refining is the mathematical process of data analysis using algorithms. Among many other possibilities, these algorithms are what enable driverless cars to operate, or a machine to beat a world champion at Go – the most complex strategy game there is.

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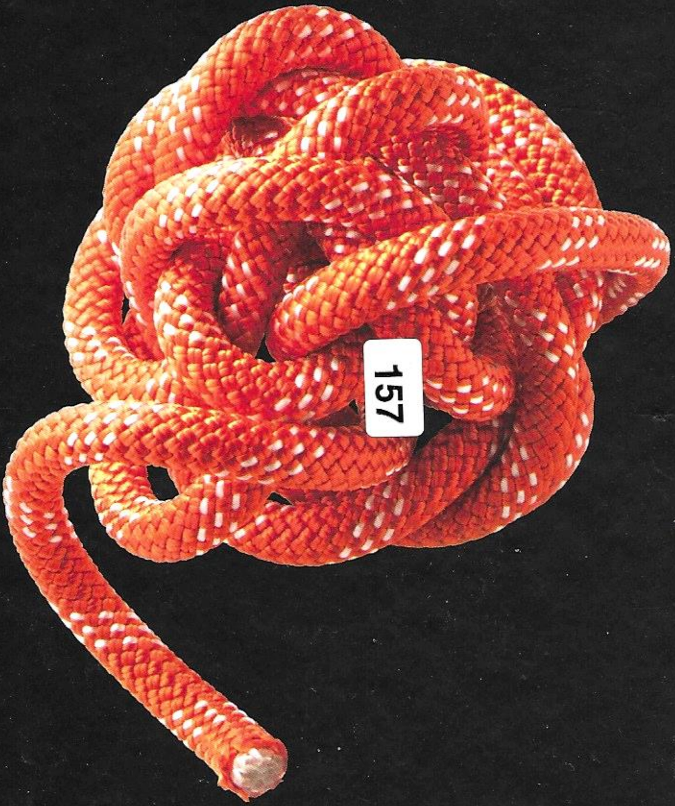
NATIONAL GEOGRAPHIC

All Tied Up

Introduction to knot theory



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All Tied Up

How can we be certain that the knot holding the climber is not going to unravel when they sway unexpectedly? Will the knot holding the sail of a boat come loose if the wind causes it to move in an unexpected way? Knots in ties made with the right or left hand appear different, but is this true or can you convert one into the other without taking the tie off? In this book we will investigate how mathematics helps us to answer these questions and how it relates to specific objects, such as DNA, which are naturally knotted.

Our mathematical world

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Living in a Small World

The mathematics of social networks

Our mathematical world

NATIONAL GEOGRAPHIC

Living in a Small World

Virtual social networks have made a strong entry into our lives, and have made the world smaller with their introduction of a new type of emotional nexus between people, regardless of their location. For their part, companies as well as social movements have found a powerful ally in these new communication channels that generate an enormous flow of information. This informational flow can be analysed using mathematical tools, allowing us not only to understand its structure and growth dynamics, but also to determine its paradoxical and deceptive effects.

Our mathematical world

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NATIONAL GEOGRAPHIC

The Story of an Imaginary Number

The square root of -1

Our mathematical world

NATIONAL GEOGRAPHIC

The Story of an Imaginary Number

In the 16th century some mathematicians were forced to work with square roots of negative numbers – an operation that apparently has no possible outcome. However, despite their unpromising origins, these ‘impossible’ numbers became indispensable in many branches of mathematics. How has the process that led to the square root of -1 moved from being ‘useful but non-existent fiction’ to an ‘important number that actually exists’? What applications do square roots of negative numbers have? How do they relate, for example, to prime numbers? This book tells the story of the square root of -1 and answers, among others, all these questions.

Our mathematical world

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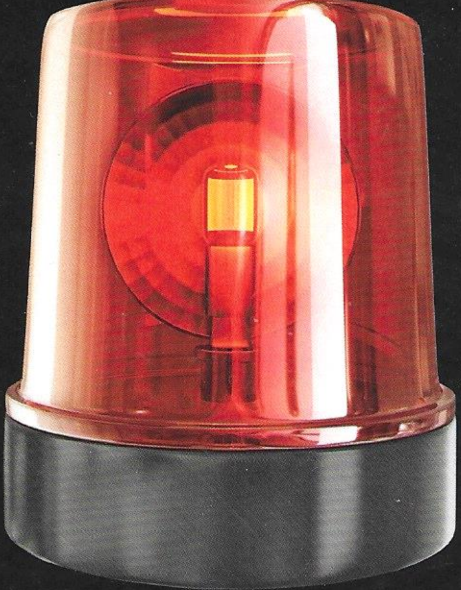
Catastrophe Theory

Between equilibrium and change



Our mathematical world

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Catastrophe Theory

Contrary to appearances, catastrophe theory is not an attempt to provide a mathematical basis for earthquakes, hurricanes, plane crashes and forest fires. In fact, this branch of mathematics was created by the Frenchman René Thom in the 1970s to study and classify phenomena characterised by sudden changes in their behaviour as a consequence of small variations. Thom's original plan was to develop mathematics capable of explaining changes and differentiations found in biology, but it soon became apparent that catastrophe theory could also be useful in fields as diverse as linguistics, physics, psychology and sociology.

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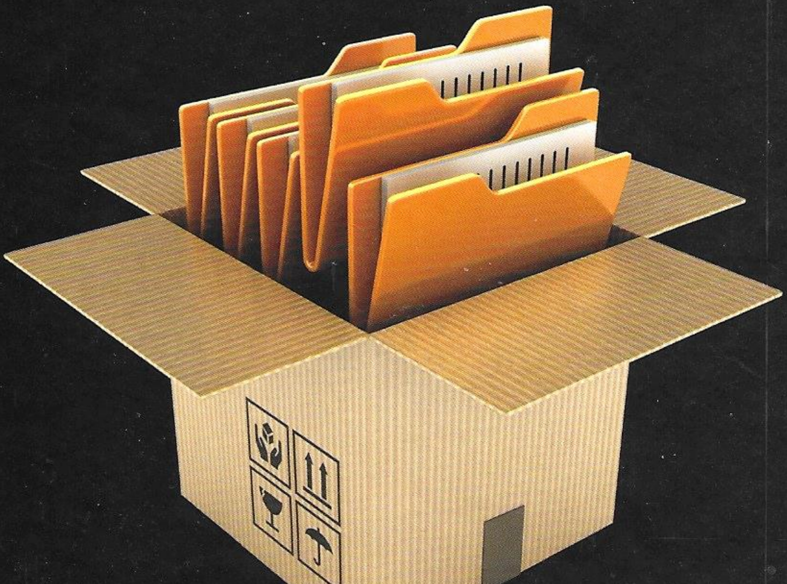
The Secret of Good Organisation

Logistics and mathematics



Our mathematical world

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The Secret of Good Organisation

This book sheds light on the mathematical models that are hidden within the complexities of logistics. Each of these aims to achieve the best results with the available resources. Efficiency, how often do we hear this word being used? In our daily lives, every activity requires organisation and optimisation. If alternatives are few, this is simple, but when the problem becomes more complex, mathematics is essential, although sometimes so well hidden that it may go unnoticed.

Our mathematical world

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NATIONAL GEOGRAPHIC

Any More Bids?

The mathematics of auctions

Our mathematical world

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Any More Bids?

Auctions are a popular form of economic transaction brimming with mathematics. They're used to allocate licences for exploiting public resources, and they provide central banks with a mechanism for injecting liquidity into the banking system. In this book, we'll delve into the mathematical intricacies of auctions, covering fields ranging from game theory to new and unexpected versions of geometry. We'll examine different auction models and the intricacies of online auctions, and we'll look at how to design a successful auction.

Our mathematical world

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NATIONAL GEOGRAPHIC

Bayes' Theorem

Targeting the truth

Our mathematical world

NATIONAL GEOGRAPHIC

Bayes' Theorem

In a world of dramatic advances, we often come across events that are unforeseen or that we mistrust. How can we control the unpredictable? Bayes' theorem, a simple mathematical rule, allows us to improve our beliefs if objective information is added to our initial beliefs: we can know what the probability is that a theory or hypothesis is true if a particular event takes place. Hence its usefulness and its numerous applications, some of them truly astonishing.

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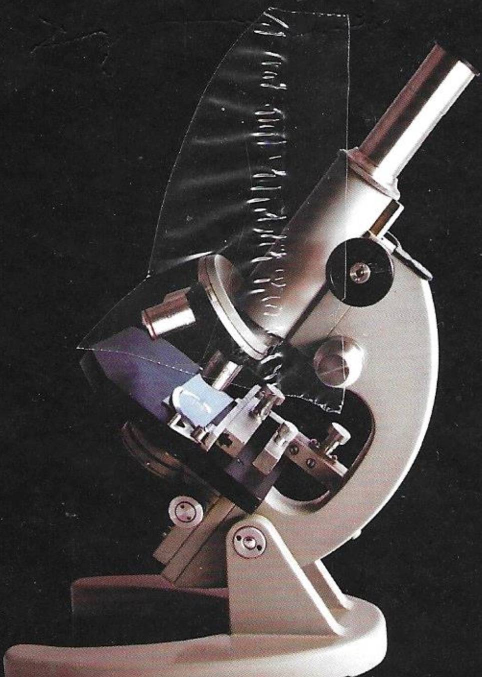
Observations, Measures and Models

The mathematics behind scientific experiments



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Observations, Measures and Models

As is well known, experimentation is a key element of the scientific method as it passes any new model or theory through the sieve of empirical evidence. However, scientific observations must be correctly planned and analysed. Different hypotheses have to be rigorously tested and the numerous measurements made must be carried out, minimising possible sources of error. It is this field where mathematics, and in particular probability and statistics, play a fundamental role, since it is the tool that allows for handling of the large amount of data generated by any experimental design.

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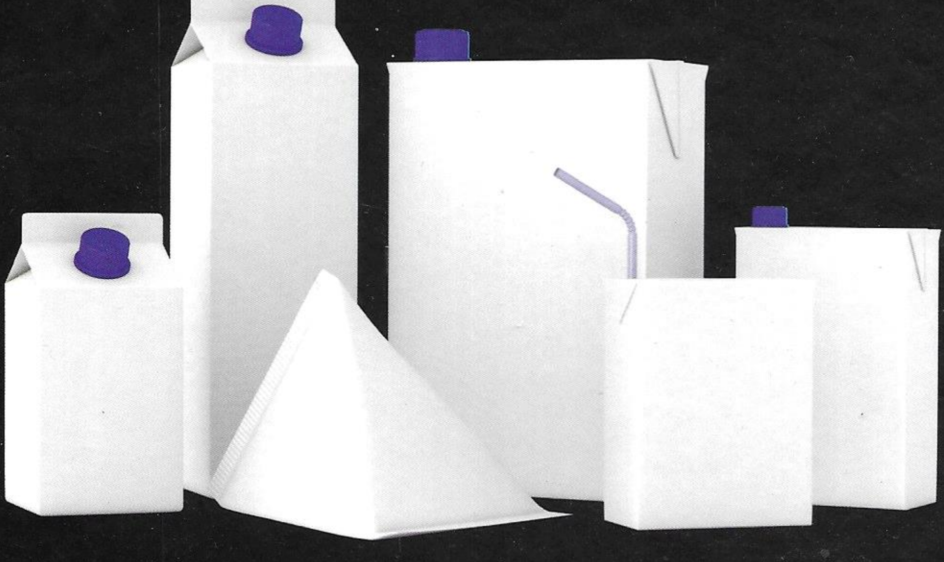
Geometry at Close Quarters

The mathematics of everyday life



Our mathematical world

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Geometry at Close Quarters

Although the majority of people don't notice it, geometry is ubiquitous: the natural world, streets, buildings, furniture, vehicles that pass by, advertisements that we see, clothes and footwear worn … even in their own body. From satellite dishes to soccer balls, from tetrabricks and drinks cans to motorways and traffic signs, geometry is in everything, a science which is very useful when travelling and is 'hidden' in the greatest works of art, as well as providing us with really ingenious games. In the final analysis geometry is involved in everything, embellishing it and seamlessly simplifying it, so that understanding its secrets provides a richer vision of our environment … and not a few surprises.

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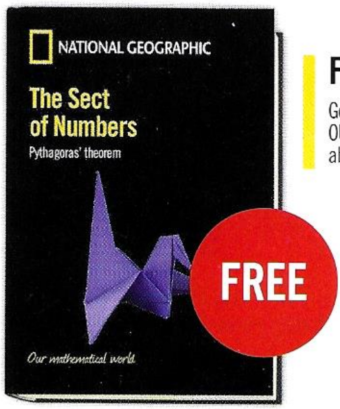

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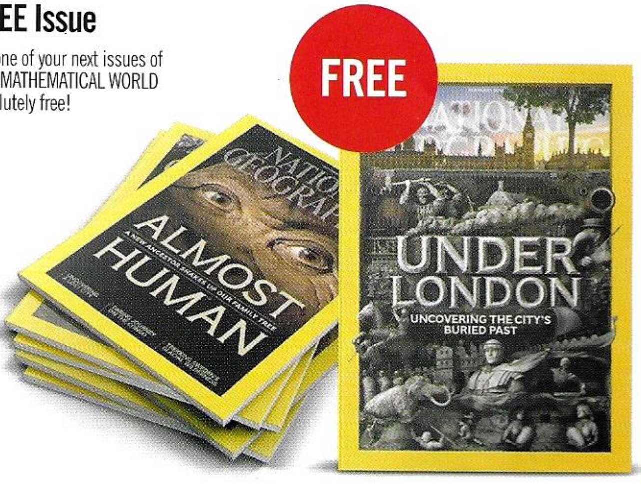

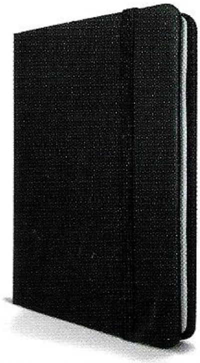

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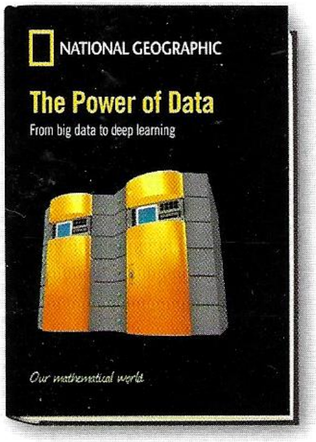
Our MATHEMATICAL WORLD

Everything we see around us, from the everyday to the most transcendental, would be indecipherable without mathematics.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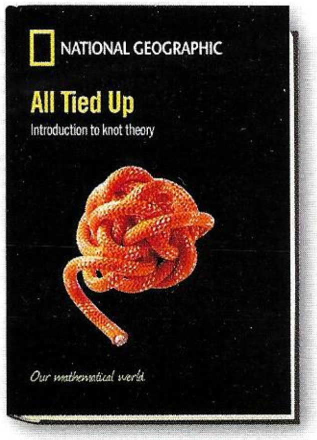
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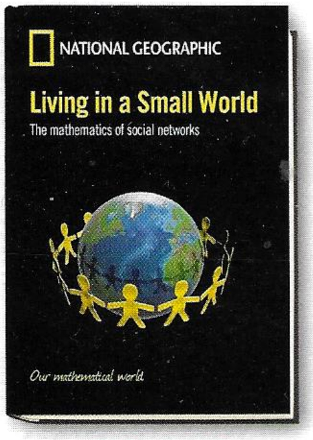
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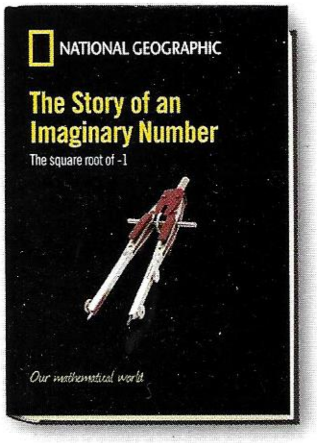
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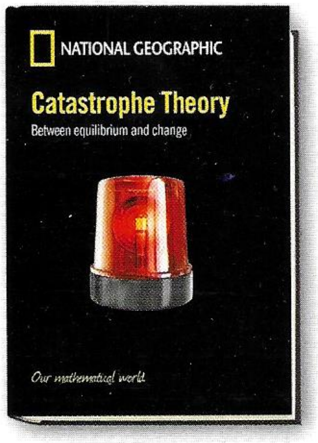
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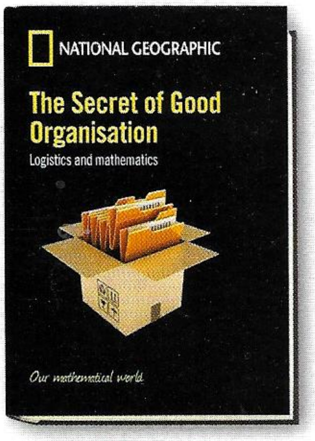
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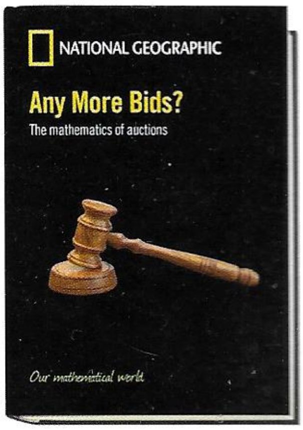
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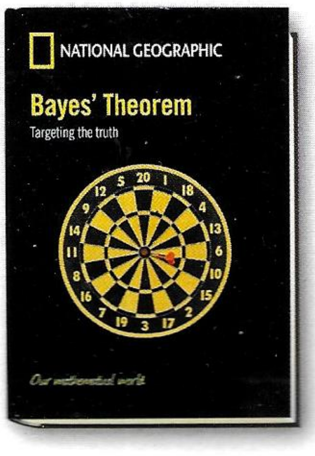
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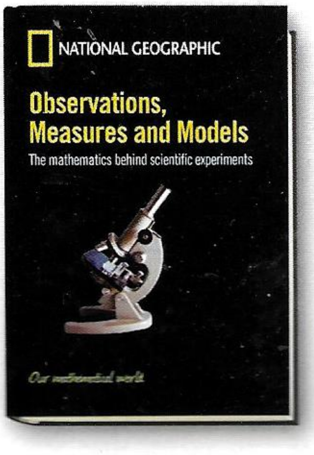
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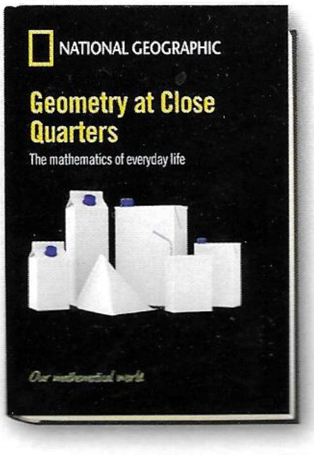
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